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Forecasting Malaysian Natural Rubber Prices: An Analysis of Trends and Factors Influencing Price Fluctuations

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Recently, the natural rubber industry has grown to be one of Malaysia's most significant economic sectors. However, Standard Malaysia Rubber (SMR20) prices have frequently fluctuated. To predict the price situation in the future, it is crucial to construct a price prediction or forecasting model. As such, a study on forecasting Malaysian natural rubber prices over the next ten years needs to be done. The data gained for this study were from Malaysian Rubber Board covering 1995 to 2022. Univariate forecasting methods such as Holt's Winter, Double Exponential Smoothing, Naive with Trend and Autoregressive Integrated Moving Average (ARIMA) were used. The best method to forecast natural rubber prices was decided based on the lowest measurement error. From the analysis, ARIMA was chosen because it has the smallest measurement error to predict natural rubber prices over the next decade. As a result, Malaysia's natural rubber prices showed an upward trend.
Keywords: Natural rubber price, forecasting, autoregressive integrated moving average, measurement forecasting error.

INTRODUCTION

In Malaysia, natural rubber is a vital commodity, and the nation is one of the top producers and exporters of this significant agricultural good worldwide (Ali *et al.*, 2021; WWF-Malaysia, 2021; Kawano, 2019). The economic contribution of Malaysia's natural rubber sector to export earnings as well as rural livelihoods is substantial. The dynamics of global demand and supply, the environment, governmental regulations and market speculation, among other things, all have an impact on the price of natural rubber in Malaysia and other rubber-producing nations (Ali *et al.*, 2021; Basri *et al.*, 2018).

The cultivation of Hevea brasiliensis trees, which are the main source of latex, the milky sap used in rubber production, is the main focus of Malaysia's natural rubber sector (Mazlan *et al.*, 2019). In Malaysia, there are several rubber plantations, with areas like Kelantan, Johor and Perak producing a sizable amount of the material. The foundation of Malaysia's rubber industry comprises these plantations and the smallholder farmers contributing to rubber farming (Ali, 2020).

Global market forces set the price of natural rubber in Malaysia, with foreign demand playing a key role. Natural rubber in Malaysia, known as Standard Malaysian Rubber 20 (SMR20) measures the impurities frequently used in numerous goods (Raha Group, 2016), particularly in the automotive sector, including vehicle tyres, bumpers and other parts. Industries like automotive, tyre manufacture, construction and healthcare are major consumers of natural rubber (Mordor Intelligence, 2023). Any demand changes in these areas can significantly impact rubber prices (Basri *et al.*, 2018). The development of emerging markets and changes in big economies are other factors that influence demand patterns and as a result, the price of natural rubber.

Supply-side variables also impact prices for natural rubber. Rainfall and temperature can impact rubber trees' productivity and the total supply of latex (Yang *et al.*, 2019). Unfavourable weather conditions like drought, floods or

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diseases like the fungus known as "white root disease" can hamper production and affect rubber prices (Lim *et al.*, 2023). The price of natural rubber in Malaysia is impacted by government regulations and laws as well (Ali *et al.*, 2021). Land ownership, taxes and export restrictions policies may directly or indirectly impact the sector and as a result, the price of natural rubber (Tuck-Hoong, 1976). Price volatility is also influenced by investor emotion and market speculation. Investors can speculate on price changes by trading rubber futures on commodities exchanges. However, this can result in short-term volatility that does not always reflect supply and demand fundamentals. It is significant to note that, like any market, the price of natural rubber varies frequently in Malaysia. It is difficult to predict price trends because various factors might affect these swings (Bashier *et al.*, 2022).

To sum up, the natural rubber price in Malaysia is influenced by global demand and supply dynamics, weather conditions, government policies and market speculation. The country's robust rubber industry and its significant contribution to the economy had placed the price of natural rubber as a subject of interest for various stakeholders, including rubber producers, manufacturers, investors and policymakers. Hence, it is crucial to create a model for predicting the price of natural rubber due to this. To help decision-makers make effective decisions, high forecast accuracy was very critical. Thus, this study aims to predict Malaysian natural rubber prices through the year 2031.

LITERATURE REVIEW

Numerous studies have been conducted to forecast the price of natural rubber, considering its importance in global markets. Several studies have utilised the Autoregressive Integrated Moving Average (ARIMA) model for forecasting natural rubber prices due to its ability to capture time series dynamics and trend patterns. These studies have demonstrated the effectiveness of ARIMA in predicting future price movements in the natural rubber market.

One notable study by Zahari *et al.* (2018) applied the ARIMA model to forecast natural rubber prices in Malaysia. The researchers used historical price data and incorporated relevant exogenous variables such as exchange rates and crude oil prices into the model. The findings indicated that ARIMA could provide accurate short-term forecasts of natural rubber prices, highlighting its practical applicability in the industry. Another study by Chawla and Jha (2009) focused on forecasting rubber prices in India using several forecasting models, including ARIMA. The researchers compared the monthly actual production data for accuracy. Furthermore, a study by Cherdchoongam and Rungreunganun (2016) employed the ARIMA model to forecast natural rubber prices in Thailand. The researchers utilised a dataset consisting of historical rubber prices and macroeconomic indicators such as world natural rubber price, synthetic rubber price, the advanced market price of Tokyo Commodity Exchange (TOCOM) as well as production and consumption of natural rubber. The results demonstrated that the ARIMA model effectively captured the price trends and provided reliable forecasts for the Thai rubber market.

These studies showcase the application of the ARIMA model in forecasting natural rubber prices, emphasising its effectiveness in capturing the underlying time series dynamics and providing reliable predictions. Researchers and practitioners interested in utilising ARIMA for natural rubber price forecasting can refer to these studies for further insights.

MATERIALS AND METHODS

***Data Collection*:** The Standard Malaysian Rubber 20 (SMR20) monthly prices were examined in this study. The data were taken from Malaysia Rubber Board (MRB), including the prices from January 1995 to December 2020. 312 observations have been identified for further analysis.

***Data Analysis*:** A time series is a collection of data points gathered and organised over time. It is a method for analysing statistical data used to comprehend and examine the patterns, trends and behaviours of a variable or group of variables over a predetermined period. Each data point in a time series has a certain timestamp or timespan attached to it, such as hourly, daily, monthly or yearly intervals.

Numerous disciplines, including finance (Kumar *et al.*, 2022), economics (Tran, 2022), meteorology (Gudziunaite and Moshammer, 2022), engineering (Rahimilarki *et al.*, 2022) and the social sciences (Arendt and Mestas, 2023), frequently use time series analysis. Researchers and analysts can use it to look on how a variable change over time, spot patterns and trends, predict the future and learn more about the underlying causes affecting the data (Aydin, 2022; Li and Jung, 2022).

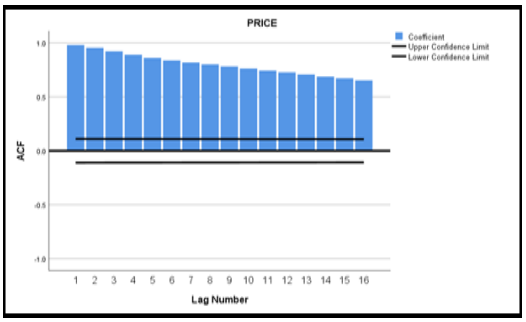
There are four components of time series, which are seasonal, trend, cyclical and irregular. The univariate time series models employed in this study are double exponential smoothing, Holt-Winter's model, naive with the trend and Autoregressive Integrated Moving Average (ARIMA) model. The autoregressive integrated moving average combines moving-average (MA) and autoregressive (AR) models. The equation for this process is:

$$Y_t = \theta_t Y_{t-1} + \tau_t \quad (1)$$

The forecasting measurement error for each approach was calculated after data analysis. This step involves determining which forecasting approach fits the data the best. The optimal approach will be chosen based on the forecast error measurement with the lowest error value. Theil Inequality Coefficient (TIC), Mean Absolute Percentage Error (MAPE), Mean Squared Error (MSE), Root Mean Square Error (RMSE) and Mean Absolute Error (MAE) will all be utilised to measure accuracy. Thus, the method chosen will be used to predict the price of natural rubber for the ensuing ten years.

RESULTS

Forecasting Methods: ARIMA method is a combination of autoregressive (AR) and moving-average (MA) models. The data for ARIMA must be stationary before it can be proceeded with the data analysis (Brockwell and Davis, 2002). Fig. 1 showed that the time series of the price of natural rubber and time was nonstationary.



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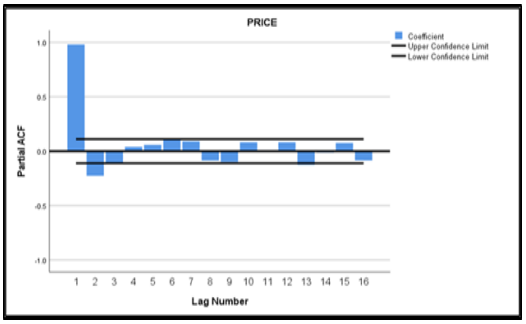

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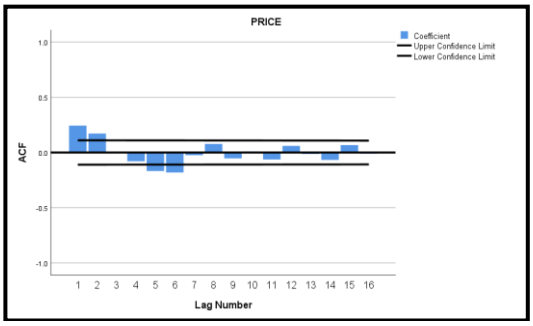
Figure 1. ACF and PACF Before Transformation.



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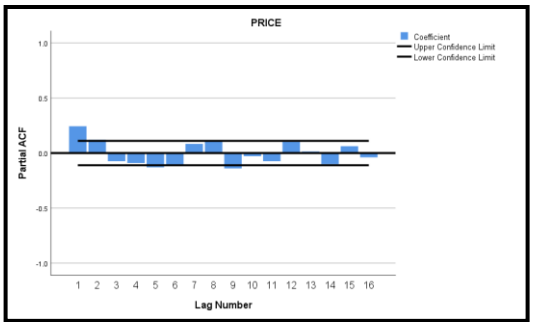

PACF

Figure 2. ACF and PACF After Transformation

This is because it does not have constant mean, variance and covariance. Later, a transformation has been done to obtain a stationary series. The data has been transformed using differencing (d) to stabilise the variance. After the transformation, the mean of the data was checked by using Autocorrelation Function (ACF) plot and Partial Autocorrelation (PACF) plot, as in Fig. 2.

Consequently, the results t obtained from Fig. 2 were used to determine the ARIMA (p, d, q) values. Those figures show that the differencing occurs once to make the data stationary, so the value of d is 1. For ACF in Figure 2, it can be seen that there are two spikes on lag 1 and 2, hence the value of q is 2. There are also two spikes between lag 5 and 6, so the p value is 2. As a result, ARIMA (2,1,2) will be used to further analysis using SPSS Statistics software as shown in Fig. 3. Thus, several standard error measurements known as Mean Absolute Error (MAE), Mean Squared Error (MSE), Root Mean Squared Error (RMSE), Mean Absolute Percent Error (MAPE) and Theil's Inequality Coefficient (TIC) were compared using several selected methods as shown in Table 1.

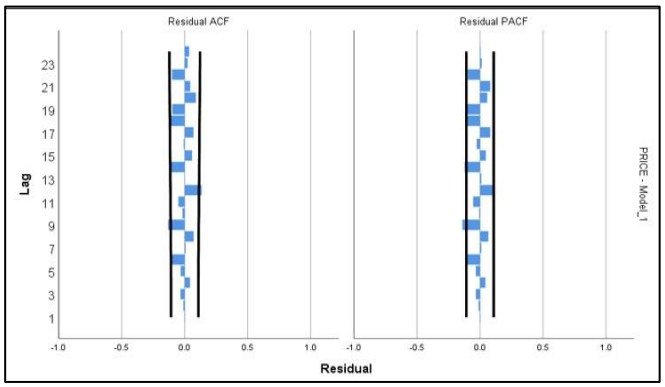

Figure 3. ACF and PACF for ARIMA (2, 1, 2).

Table 1. List of all the error measurements.

Types of Error/Methods	MAE	MSE	RMSE	MAPE	TIC
Naïve with Trend	0.442	0.388	0.623	5.691	0.0434

Double Exponential Smoothing	0.411	0.961	0.627	6.194	0.0230
Triple Exponential Smoothing (Holt's Method)	0.38	0.347	0.589	5.646	0.0380
Autoregressive Integrated Moving Average Method (ARIMA) (2, 1, 2)	0.372	0.311	0.558	5.612	0.0022

From the result in Table 1, it can be seen that ARIMA has the least error value in each error measurement as compared to the other methods. The least error implies the best-fit model. Therefore, this comparison has proven that ARIMA is the best method and was chosen to forecast the value of natural rubber prices in the following section.

***Forecasting via Autoregressive Integrated Moving Average Method (ARIMA)*:** Using the best-fitting model, this study's main goal is to predict natural rubber prices for the ensuing ten years (2022–2031). As a result, the values for future forecasting were calculated using ARIMA. Table 2 tabulates the outcomes of utilizing the ARIMA (2,12) approach on the dataset using SPSS. Subsequently, Figure 4 shows the trend graphically.

Table 2. Future Predicted Values for Malaysia's Natural Rubber Price During the Next Ten Years.

Apr-22	8.96	Apr-24	9.32	Jan-26	9.63	Jan-28	9.99	Jan-30	10.34
May-22	8.99	May-24	9.33	Feb-26	9.64	Feb-28	10.00	Feb-30	10.36
Jun-22	9.01	Jun-24	9.34	Mar-26	9.66	Mar-28	10.02	Mar-30	10.37
Jul-22	9.02	Jul-24	9.36	Apr-26	9.67	Apr-28	10.03	Apr-30	10.39
Aug-22	9.01	Aug-24	9.37	May-26	9.69	May-28	10.05	May-30	10.40
Sep-22	9.02	Sep-24	9.39	Jun-26	9.70	Jun-28	10.06	Jun-30	10.42
Oct-22	9.03	Oct-24	9.40	Jul-26	9.72	Jul-28	10.08	Jul-30	10.43
Nov-22	9.06	Nov-24	9.42	Aug-26	9.73	Aug-28	10.09	Aug-30	10.45
Dec-22	9.08	Dec-24	9.43	Sep-26	9.75	Sep-28	10.11	Sep-30	10.46
Jan-23	9.10	Jan-25	9.45	Oct-26	9.76	Oct-28	10.12	Oct-30	10.48
Feb-23	9.11	Feb-25	9.46	Nov-26	9.78	Nov-28	10.13	Nov-30	10.49
Mar-23	9.12	Mar-25	9.48	Dec-26	9.79	Dec-28	10.15	Dec-30	10.51
Apr-23	9.13	Jan-25	9.45	Jan-27	9.81	Jan-29	10.16	Jan-31	10.52
May-23	9.15	Feb-25	9.46	Feb-27	9.82	Feb-29	10.18	Feb-31	10.54
Jun-23	9.16	Mar-25	9.48	Mar-27	9.84	Mar-29	10.19	Mar-31	10.55
Jul-23	9.18	Apr-25	9.49	Apr-27	9.85	Apr-29	10.21	Apr-31	10.57
Aug-23	9.20	May-25	9.51	May-27	9.87	May-29	10.22		
Sep-23	9.21	Jun-25	9.52	Jun-27	9.88	Jun-29	10.24		
Oct-23	9.23	Jul-25	9.54	Jul-27	9.90	Jul-29	10.25		
Nov-23	9.24	Aug-25	9.55	Aug-27	9.91	Aug-29	10.27		
Dec-23	9.25	Sep-25	9.57	Sep-27	9.93	Sep-29	10.28		
Jan-24	9.27	Oct-25	9.58	Oct-27	9.94	Oct-29	10.30		
Feb-24	9.29	Nov-25	9.60	Nov-27	9.96	Nov-29	10.31		
Mar-24	9.30	Dec-25	9.61	Dec-27	9.97	Dec-29	10.33		

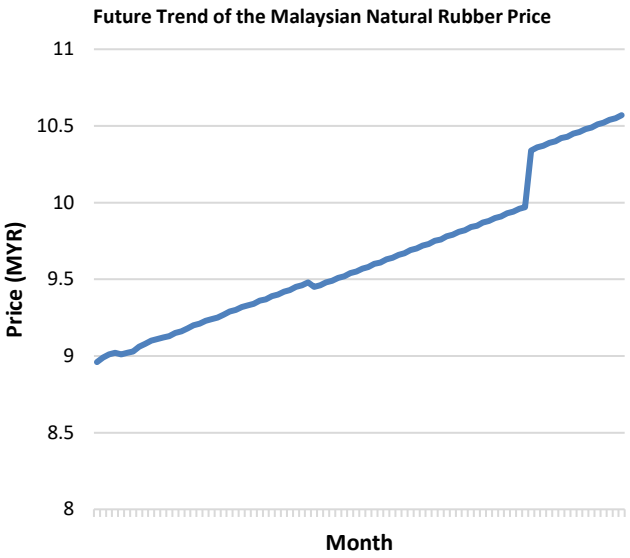

Figure 4. The trend of Malaysian Natural Rubber.

Malaysia's natural rubber prices would fluctuate during the following ten years (upward and downward). Nevertheless, due to several circumstances, this is a typical condition in the natural rubber price industries. Overall, the price of rubber rises gradually over time. Fascinatingly, it is predicted that the cost of natural rubber will rise from MYR 8.96 in April 2022 to MYR 10.57 in April 2031.

DISCUSSION

This study explored into the forecasting of Malaysian natural rubber prices using a range of univariate forecasting methods and determined that the Autoregressive Integrated Moving Average (ARIMA) model provides the most accurate predictions. The selection of ARIMA as the optimal forecasting method holds significant implications for various stakeholders within the natural rubber industry. Furthermore, the identified upward trend in Malaysian natural rubber prices underscores potential positive economic implications for the nation.

The superiority of the ARIMA model in forecasting natural rubber prices is attributed to its ability to capture temporal dependencies, autocorrelation and seasonality present in the data. The ARIMA model's flexibility allows it to adapt to varying patterns and trends within the time series data, making it well-suited for modeling the complex dynamics of rubber prices. Its success in this study aligns with its proven effectiveness in numerous other time series forecasting applications.

The findings of this study offer valuable insights into forecasting Malaysian natural rubber prices using the ARIMA model. Then, the predicted ARIMA model reveals that Malaysia's natural rubber prices show an upward trend during

the following ten years. Fascinatingly, it is predicted that the cost of natural rubber will rise from MYR 8.96 in April 2023 to MYR 10.57 in April 2031. This increasing number may be due to the higher demand for natural rubber in the industrial sector, as Roy *et al*. (2020) highlighted. This trend indicates that natural rubber will still have an impact on the Malaysian industry for the next ten years.

***Conclusion*:** This study aims to predict the price of natural rubber in Malaysia (SMR20) for the next ten years. The ARIMA approach was employed in this investigation. 0.372 for MAE, 0.311 for MSE, 0.558 for RMSE and 5.612 for MAPE are the measured values of predicting error for ARIMA. The outcomes demonstrate that the ARIMA approach had outstanding accuracy and the lowest error. Based on this methodology, the results indicate that the price of SMR20 will fluctuate during the following ten years. Despite this, a number of reasons can cause the price of natural rubber to fluctuate, making this a typical occurrence in the industry. Additionally, the price of natural rubber progressively grew from MYR 9.16 (2.05 USD) in June 2023 to MYR 10.57 (2.37 USD) in April 2031.

To be concluded, this research aids in strategic decision-making and policy formulation within the rubber industry. This systematic analysis will help our agriculture industry to set a precedent for future research in agricultural science. By showcasing the successful integration of quantitative techniques into the agricultural domain, this study inspires researchers to explore analogous methodologies for predicting other commodity prices or addressing different challenges within the sector.

***Authors contributions statement*:** Zahayu Md Yusof and Nor Farah Hanim Mohamad Norizan: Carried out the research and provided the theoretical framework. Zakiah Hashim: Conceptualised the research topic and kept track of the investigation's development. Rosshairy Abd Rahman and Siti Nor Asyikin Mohd Razali: Revised and improved the article. Rosshairy Abd Rahman and Zahayu Md Yusof: Anchored the review and modifications and approved the submission of the article.

***Conflict of interest*:** The authors agree that this research was undertaken without any self-benefits, commercial or financial conflicts, and they state that they have no competing interests with the funders.

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***Ethical statement*:** This article does not contain any studies with human participants or animals performed by any of the authors.

***Availability of data and material*:** We affirm that the submitted manuscript is our original work, which has never been published and is not being considered for publication elsewhere.

***Code Availability*:** Not applicable

***Consent to participate*:** This research study includes all of the writers.

***Consent for publication*:** All authors have given their permission for this research study to be published in JGIAS.

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